# ESTUARINE SHORELINE INVENTORY
## FOR
# PENDER, NEW HANOVER, AND BRUNSWICK COUNTIES, NORTH CAROLINA

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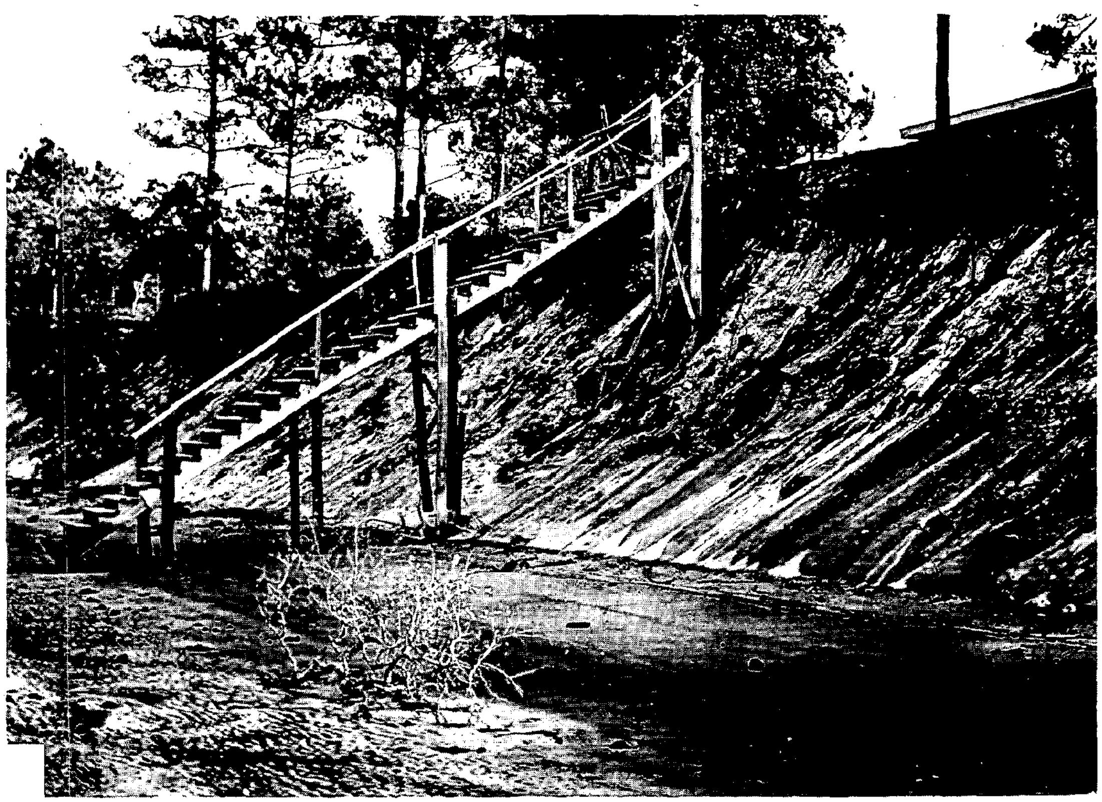

STATE OF NORTH CAROLINA
DEPARTMENT OF NATURAL AND ECONOMIC RESOURCES
COASTAL RESOURCES COMMISSION

# ESTUARINE SHORELINE INVENTORY
# FOR
# PENDER, NEW HANOVER, AND BRUNSWICK COUNTIES, NORTH CAROLINA

by

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CONTENTS

## ABSTRACT

Shoreline erosion within navigable sections of the estuaries of Pender, New Hanover, and Brunswick counties has been studied. Through the use of a shoreline classification scheme, patterns of shoreline erosion versus shoreline characteristics are delineated. Variables affecting shoreline erosion rates are: bank height and composition; type and frequency of waterway traffic; fetch and orientation of the shoreline; and proximity of shoreline to a tidal channel. Field observations and laboratory analysis of shoreline surveys indicate that the major cause of shoreline erosion within the Atlantic Intracoastal Waterway and adjacent waters is due to boat wake activity. Erosion along the Cape Fear River shoreline is minimal, with greatest erosion a function of seasonal storm activity. A series of estuarine shoreline maps indicating bank type and erosional activity has been compiled for use in determining areas of erosional activity.

Conclusions and recommendations indicated by this investigation are:

1) Shoreline erosion along the AIWW is primarily a function of man's activities.

2) Certain critical areas of eroding shoreline could be controlled through utilization of proper shoreline protection techniques or establishment of "no-wake" zones.

3) Proper land use planning coupled with effective zoning ordinances could reduce the possibility of property damage due to seasonal storm activity.

4) Landowners along coastal shorelines should be made aware of all the consequences of owning estuarine shoreline property.

## ACKNOWLEDGEMENTS

It is a pleasure to thank the Coastal Resources Commission for contacting us to conduct this study. Mike Black of the CRC was responsible for coordinating the efforts of numerous state agencies to provide cars, boats, etc. and giving constant support to our efforts. Access to aerial photographic coverage was graciously provided by the USDA Soil Conservation Service offices in Pender, New Hanover, and Brunswick counties. Special thanks go to three East Carolina University faculty members: Dr. Vince Bellis and Dr. Stanley Riggs who made numerous helpful suggestions; and to Dr. Mike O'Connor who provided useful ideas as well as editorial commentary.

## INTRODUCTION

Trends for the past few years indicate that coastal shoreline development in North Carolina is progressing at an ever-increasing rate. The need for a better understanding of shoreline erosion processes has prompted numerous investigations through various institutions and agencies(USDA Soil Conservation Service, 1975; Bellis, O'Connor, and Riggs, 1975; U.S. Army Corps of Engineers, 1971). This report evaluates estuarine shoreline erosion along the Atlantic Intracoastal Waterway(AIWW) and adjacent waters, and segments of the Cape Fear River in Pender, New Hanover, and Brunswick counties, North Carolina(figure 1). Increasing development along the AIWW necessitates evaluation of the shoreline erosion situation for the tri-county area. Although the Cape Fear River below Wilmington has not undergone the rapid shoreline development experienced along other large coastal rivers, the potential for development is high, so this area is included in this report.

## PREVIOUS INVESTIGATIONS

The United States Department of Agriculture Soil Conservation Service conducted a preliminary study of estuarine shoreline erosion for New Hanover and Brunswick counties under the direction of L. D. Hunning(Hunning, 1975). Comparative analyses of aerial photographs for a 25-30 year period were made with net erosion being calculated by the distance of shoreline migration between photographs. Results

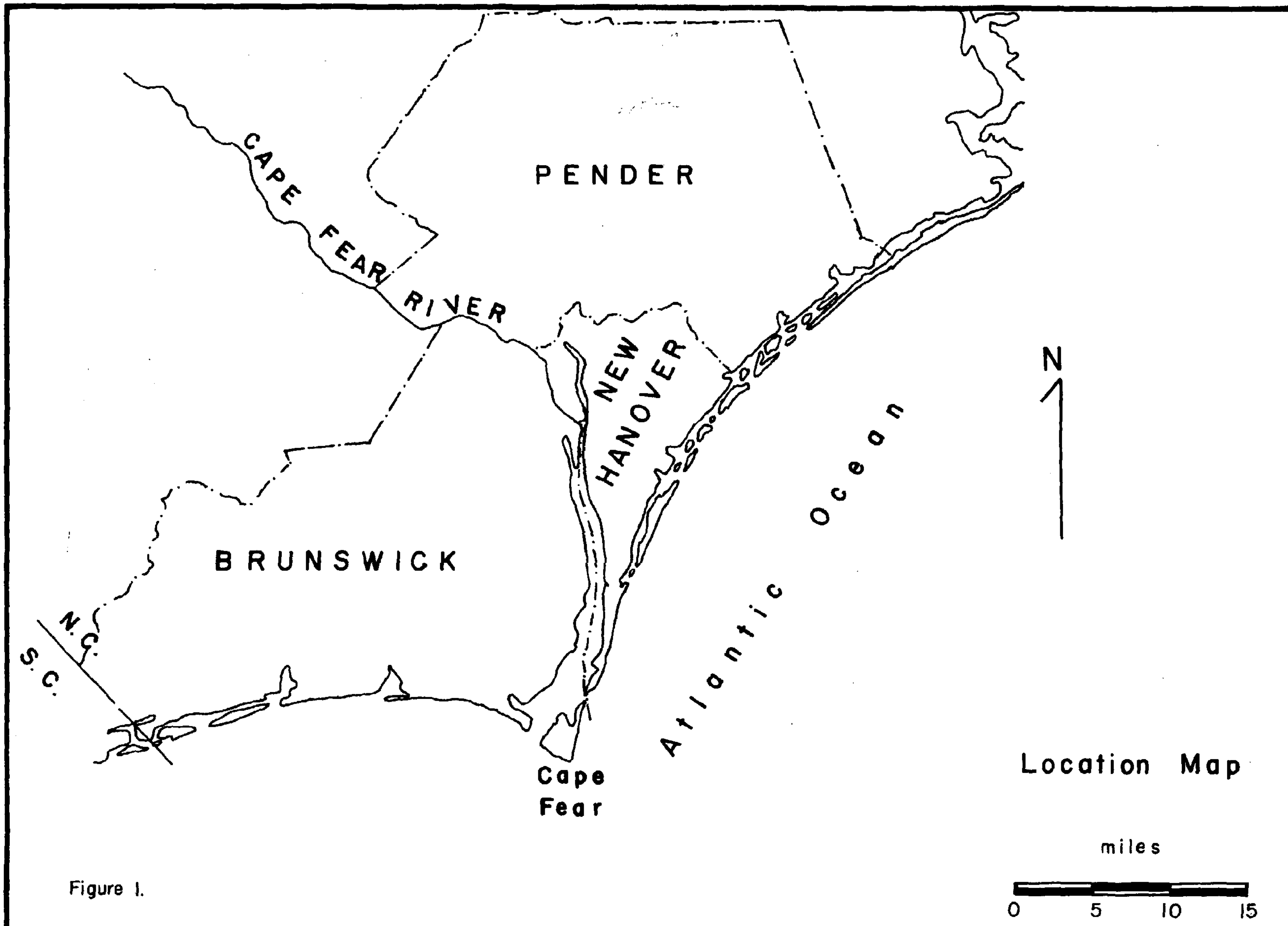

PENDER
CAPE FEAR RIVER
NEW HANOVER
BRUNSWICK
N.C.
S.C.
Cape Fear
Atlantic Ocean
N
Location Map
miles
0 5 10 15

Figure 1.

indicated shoreline erosion to be minimal, so a more detailed study of these two counties was not undertaken.

A study by the U. S. Army Corps of Engineers(1971) summerized the general characteristics of ocean and estuarine shoreline, and located specific areas of erosional activity. However, the report did not attempt to define the mechanisms or variables involved in estuarine shoreline erosion.

## GEOLOGIC SETTING

The Pender-New Hanover-Brunswick estuarine shoreline is primarily composed of marshland peat or Pliocene and Pleistocene sands and gravels. A prominent topographic feature known as the Suffolk Scarp parallels the shoreline throughout much of the study area. This escarpment forms many of the high banks that occur along the waterway. Seaward of this scarp lies the Pamlico Terrace--a gently undulating surface with elevations averaging less than ten feet. Both the Suffolk Scarp and Pamlico Terrace are believed to have been created during one of the last high stands in sea level, either 40,000 or 100,000 years ago. The Suffolk Scarp is considered by geologists to be a remnant shoreline, and the Pamlico Terrace an associated off-shore ocean floor.

For the past 18,000 years, worldwide eustatic sea level has been rising. Recent estimates set the current rate of rise to be between 0.5-1.5 feet per century. This "flooding" effect of coastal drainage systems by a transgressing sea is responsible for the formation of the estuarine river systems of eastern N. C., such as the Cape Fear and Neuse River systems. Most shoreline erosion is a result of this rising sea level.

Recent studies by Balaz(1974) and Hicks(1972) suggest that eastern N. C. is currently experiencing vertical crustal movements in the earth's crust. Two major tectonic elements, the Cape Fear Arch and the Pamlico Basin(fig. 2), influence the rate of inundation for coastal counties. The Pamlico Basin is subsiding at a rate of 5 mm/year, whereas the Cape Fear Arch is rising at an average rate of 5-6.5 mm/year(Balaz, 1974). This uplift in the Pender-New Hanover-Brunswick county area counteracts the effect of eustatic sea level rise and slows the overall rate of shoreline erosion. This tectonic effect, coupled with a general absence of large, open-water bodies along southeastern N. C., explains the rather slow natural erosion of estuarine shoreline.

## ESTUARINE SHORELINE CLASSIFICATION

For the purpose of evaluating the various factors involved in estuarine shoreline erosion, a shoreline classification scheme was devised(modified after Bellis, O'Connor, and Riggs, 1975). Bank height and composition, general floral types, land useage, shoreline protection features, and severity of erosion are included in the classification. The shoreline was surveyed by boat, with continuous typing of the shoreline recorded on base maps. Aerial photographs, navigational charts, and topographic maps greatly facilitated the field classification. In order to obtain additional information concerning erosion and general environmental processes, numerous interviews were conducted with landowners residing along the shoreline. Through the use of this classification scheme, patterns of erosion versus shoreline features were discerned.

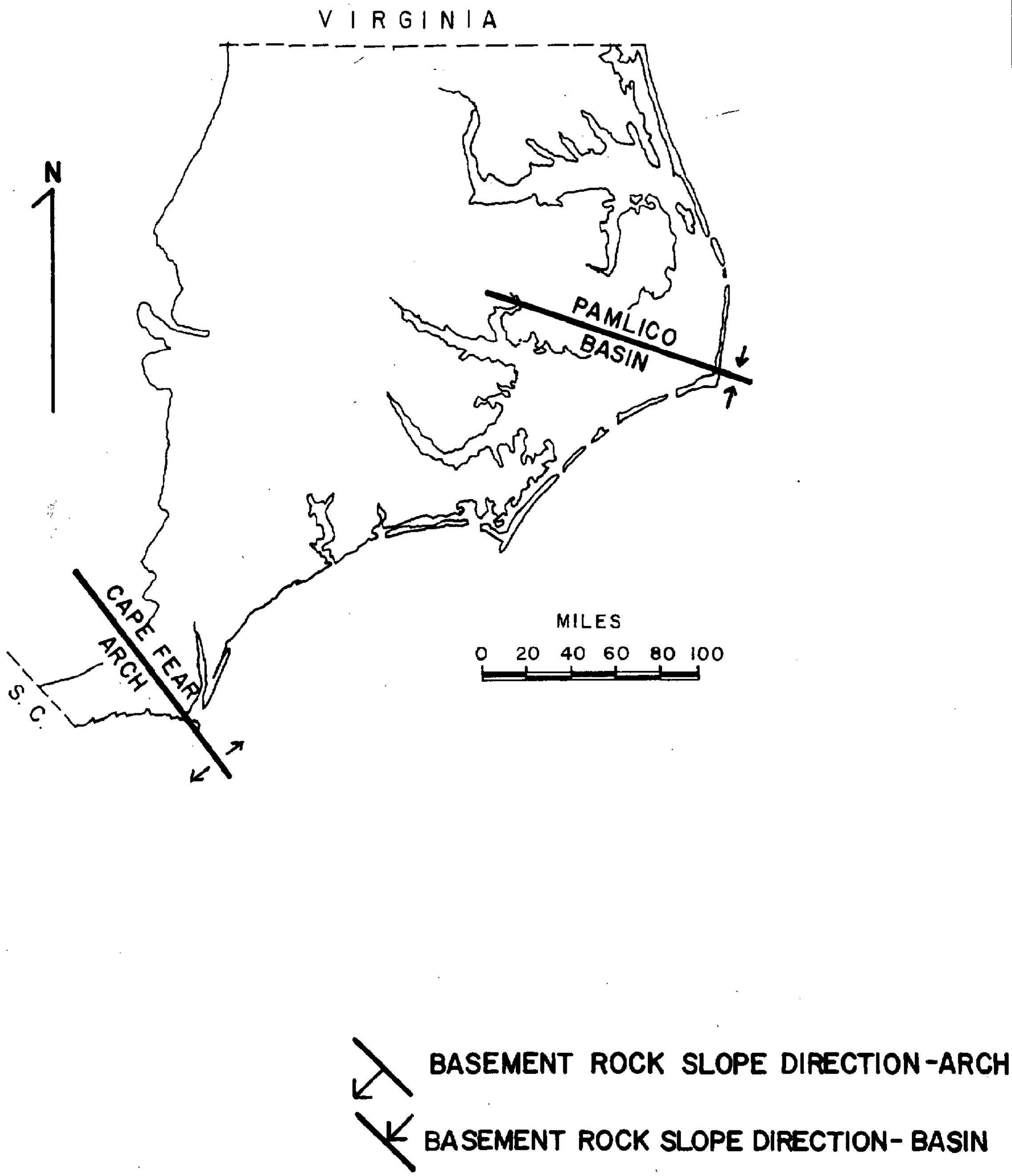

VIRGINIA
N
PAMLICO BASIN
CAPE FEAR ARCH
S. C.
MILES
0 20 40 60 80 100
BASEMENT ROCK SLOPE DIRECTION-ARCH
BASEMENT ROCK SLOPE DIRECTION- BASIN

Figure 2.

Three major shoreline types are included in the classification (table 1). The severity of erosion of identical shoreline types may differ greatly due to local variables which influence the extent and character of erosion.

Table 1. Estuarine Shoreline Classification for Pender, New Hanover, and Brunswick Counties, North Carolina(modified after Bellis and others, 1975).

| SHORELINE TYPE | *EROSION RATE(ft/yr) |
|---|---|
| I. Marsh Grass | 1 |
| II. Sand Banks | |
| A. Bluff(+20 feet) | ≥2 |
| B. High Bank(5-20 feet) | ≥2 |
| C. Low Bank(1-5 feet) | 2 |
| III. Sand Banks with Marsh Fringe | 1 |
| A. Bluff(+ 20 feet) | |
| B. High Bank(5-20 feet) | |
| C. Low Bank(1-5 feet) | |

*Rates are approximations and vary according to local conditions.

## Variables affecting erosion

Major variables which must be taken into account when evaluating the erosion potential and erosion rate for any given area are discussed below.

1. Type and frequency of waterway traffic--Without exception, each AIWW shoreline landowner interviewed attributes the shoreline erosion problem to boat wakes produced by fast-moving, deepdraft, pleasure craft and barges. During the spring and fall the AIWW becomes the major north-south passageway for pleasure boats travelling the east coast. Yachts can,

at higher speeds, throw wakes up to four feet high, creating a tremendous amount of wave energy that is ultimately expended upon the shoreline. Thus, shoreline erosion along the waterway is almost totally attributable to boat wakes.

Barge traffic utilizes the AIWW yearround, but due to the general barge design and slow speeds virtually no wake is produced. Barge movement does, however, create a water "withdrawl-surge" action as it passes along the waterway. Figures 3 through 6 illustrate the types of water motion produced by the passage of a barge. Although this surge does contribute to shoreline erosion, the overall effect is minimal when compared to the high energy waves produced by yachts.

Figure 3. Narrow stretch of AIWW with typical marsh shoreline soon to be affected by wake action of passing barge.

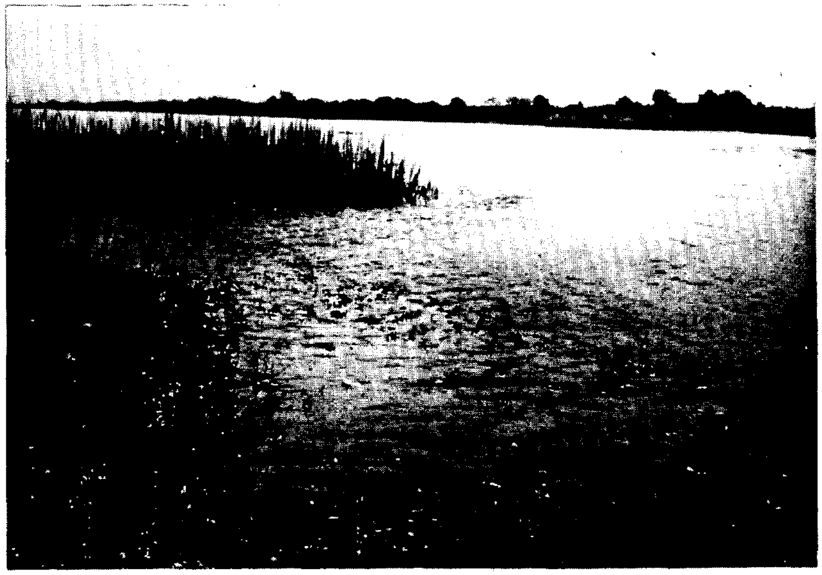


Figure 4. As barge passes, the water is drawn away from the shoreline. The amount of water level change is related to the width of the channel.

Figure 5. Water surges back against the shoreline causing erosion of the marsh.

Figure 6. Normal water level returns, but secondary water oscillations continue for some time, keeping fine sediments suspended.

Since erosion along the waterway is caused by large boat traffic, the erosion rate will be a function of the type and frequency of traffic that travels the waterway. Local residents agreed that the erosion rate has increased over the past few years due to an increase in vessel traffic, size, and speed.

2. Tide level--The 3-4 foot tidal range in the study area(U. S. Coast and Geodetic Survey, 1971) greatly affects the intensity of erosion for a given shoreline type. At high tide, boat wakes will pass over the low marshshore and break on the marsh grass, thus not causing any erosion of the marsh peat. Bank shorelines can be severely eroded at high tide if boat wakes break against the bank. At low tide, very little erosion occurs as long as extensive mud flats or sand shoals lie seaward of a particular bank or marsh.

3. Width of waterway--The intensity of shoreline erosion activity along the AIWW is also a function of distance from the main waterway channel. Generally, the closer the shoreline is to the channel, the greater the erosion potential. Where the waterway is wide, mud flats or shoals occur on one or both sides of the channel. These are shallow water areas at high tide, thus aiding in dissipation of wave energy. At low tide these flats and shoals separate the high tide shoreline from the water, thus serving as a buffer zone to oncoming wakes(fig. 7). As previously stated, barges create withdrawl-surge wave motions along their paths. Narrower stretches of the waterway are particularly susceptible to this effect primarily due to the short distance between the shoreline and moving vessel.

Figure 7. Sand shoals exposed at low tide act as a buffer zone, dispersing wake energy, protecting the bank from erosion.

4. Fetch and orientation of shoreline--Wind patterns for this area annually shift from a northeast direction in the fall and winter months to the southwest during the spring and summer(U. S. Naval Weather Service, 1970). Erosion due to wind-induced wave activity is a function of the geographical orientation and fetch of the shoreline. The fetch along most of the estuarine coastline is too small for generation of higher energy waves that contribute to shoreline erosion. There are reaches of the Cape Fear River with fetches greater than one mile. However, most of the river is quite shallow with numerous shoals and dredge spoil islands that together inhibit creation of large waves that would erode the shoreline.

5. Proximity to a tidal channel--Tidal channels intersect the waterway at numerous points. Due to the scouring effect of changing tides, banks along the mouths of large tidal channels may be sites for erosion(fig. 8). In many instances, erosion has cut back to expose dredge spoil to wave action, thereby increasing sediment influx into the waterway.

## Shoreline types

The salt marsh shoreline will be discussed as a single unit, although most of the AIWW shoreline is lined by a marsh border that may fringe a low, high, or bluff-type bank.

1. Salt marsh peat--Salt marsh shoreline fringes most of the AIWW and low-lying drainages of the Cape Fear River. Most of the seaward side of the AIWW is comprised of broad expanses of salt marsh and dredge spoil islands(fig. 9). Significant erosion of the marsh peat

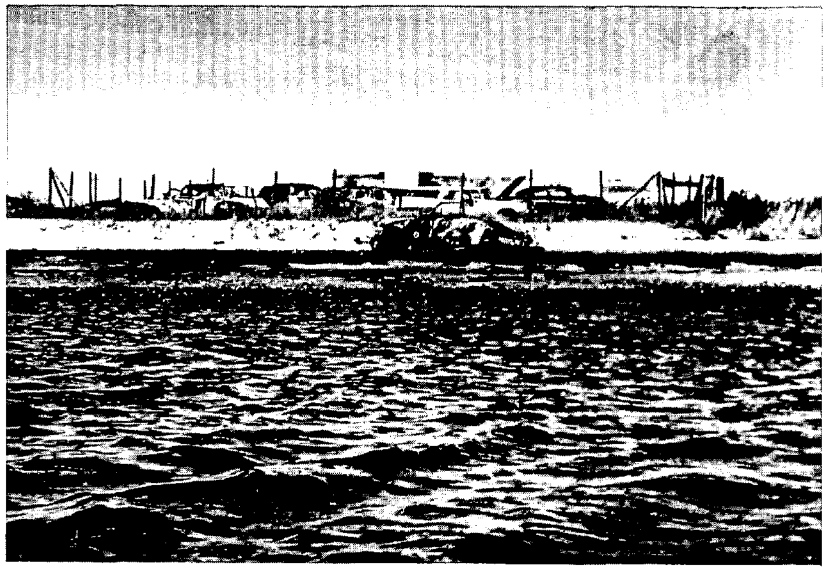


Figure 8. Erosion along tidal channel exposing peat beds.

occurs during low tide. At high tide, boat wakes tend to ride over the marsh peat and into the grass marsh, where the baffling effect of the grass dissipates the wave energy. As the tide level begins to drop, waves tend to break upon, or directly in front of the peat. Undercutting of the peat will proceed until the undercut peat will sag and eventually break off in large blocks and fall into the water(fig. 10).

Salt marsh serves as an important energy-absorbing buffer zone in areas where a higher bank borders the landward edge of the marsh. As long as this fringe exists, the low, high, or bluff bank is protected from wave activity. Without this fringing marsh, the bank would erode at a rapid rate, forcing the landowner to utilize some form of shoreline protective measure.

2. Low, high, and bluff bank--In areas where no marsh fringe exists, the banks will erode quite readily since they are usually composed of

Figure 9. Seaward view of extensive salt marsh(taken from atop spoil pile).

unconsolidated sands(fig. 11). Typically, the seaward edge of the bank is composed of sand or mud flats which are exposed during low tide. These flats cause boat wakes to break far away from the bank at low tide, thus inhibiting erosion of the bank. At high tide, waves will travel over these shoals and break directly against the bank. Undercutting of the bank causes trees and shrubs to fall into the waterway, where they become navigational hazards. Sediment derived from the bank will be moved over the flat and into the waterway channel. The volume of sediment produced is a function of the erosion rate and bank height.

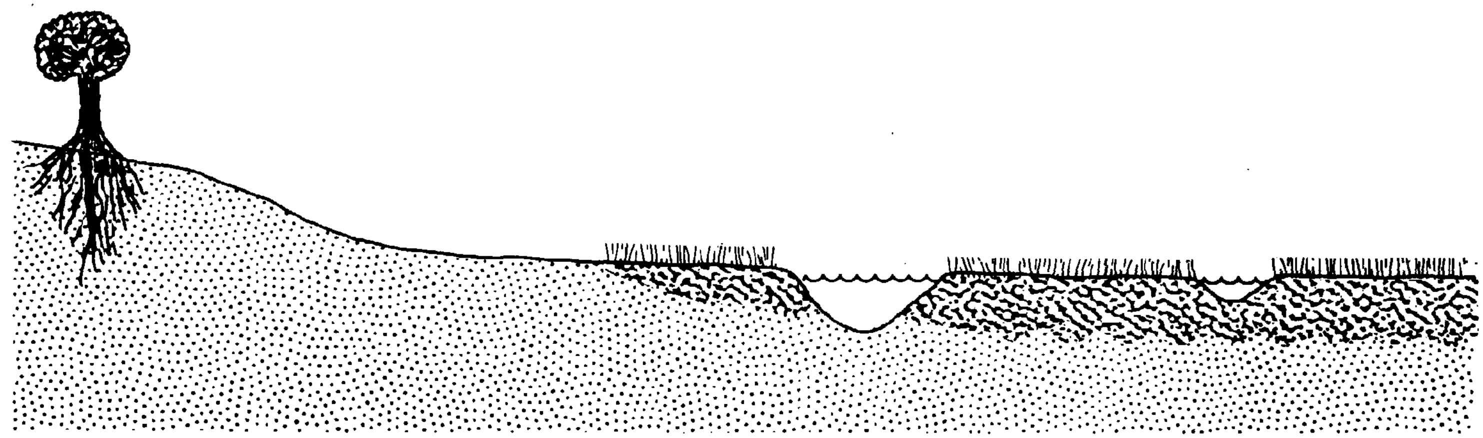
Periodically the AIWW channel is dredged with spoil dumped on bordering marshlands. Figure 12 illustrates how, in some instances, the overall effect can be visualized as the transfer of sediment from one side of the waterway to the other side.

Figure 10. Erosion of marsh grass shoreline. The peat is undercut, breaking off in blocks.

Figure 11. Slumping trees resulting from the erosion of a high bank.

Schematic Sequence of Erosion-Deposition-Dredging in the AIWW

12a.



12b.

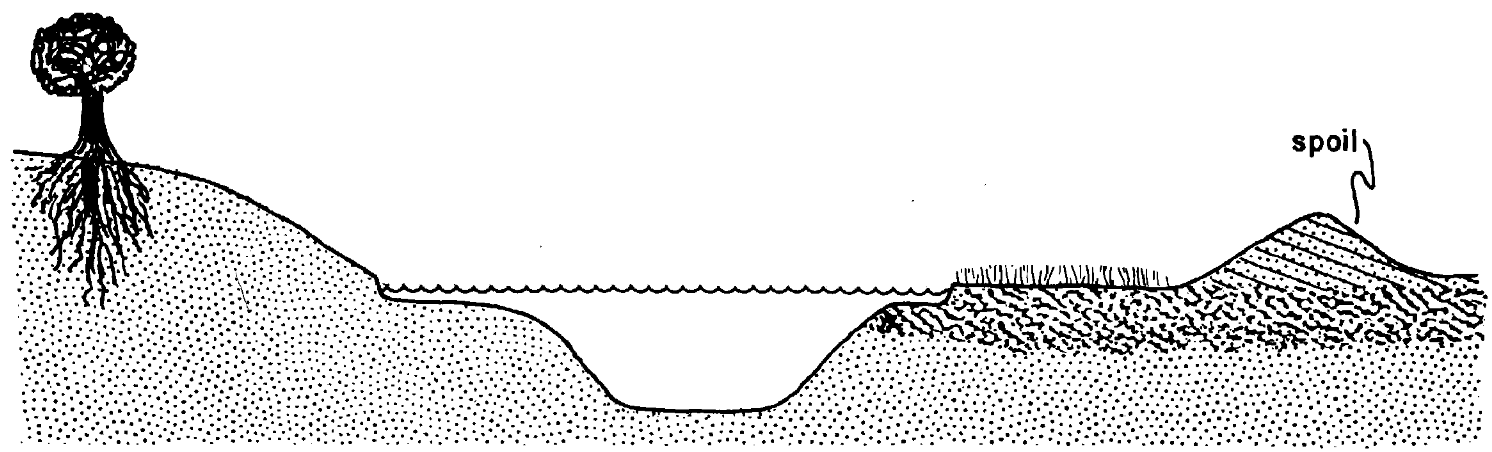
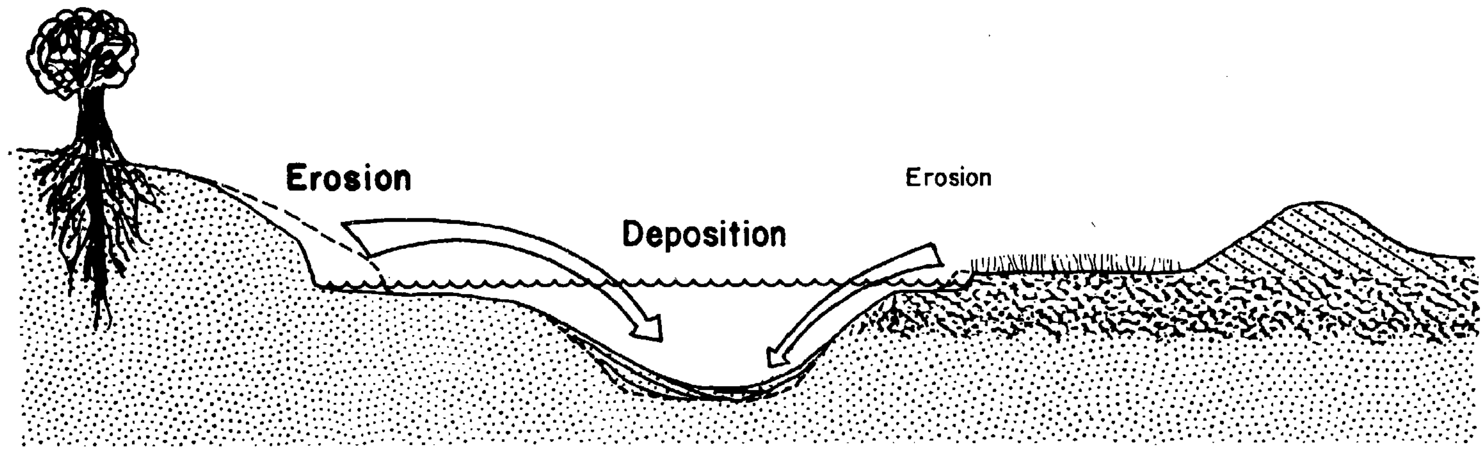



Figure 12a. Natural system - pre-waterway
Figure 12b. Initial dredging of waterway

12c.




12d.

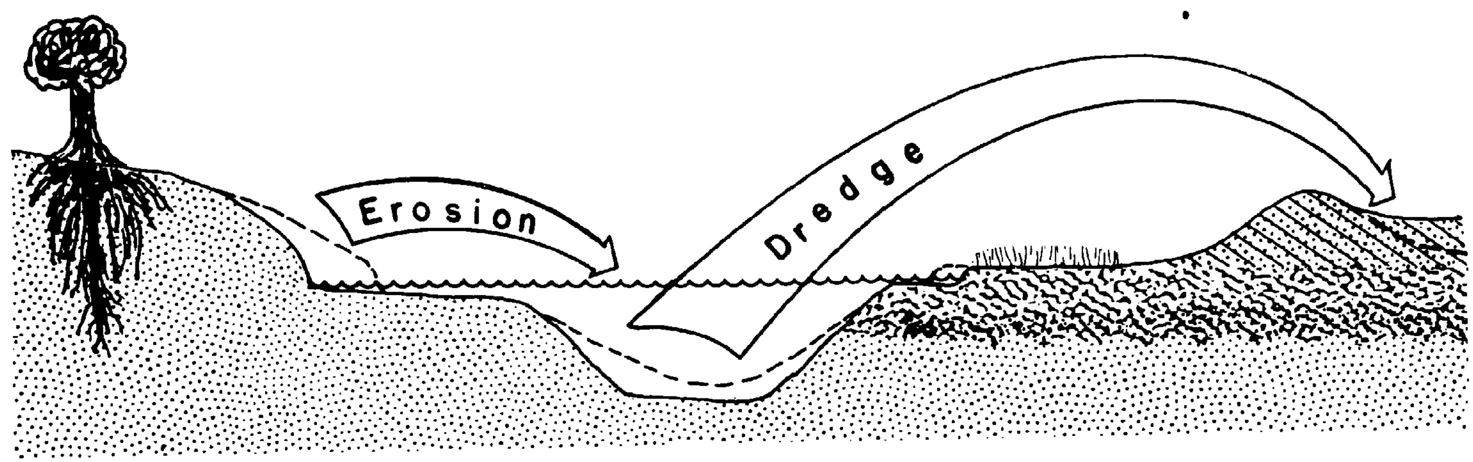



Figure 12c. System trying to reach equilibrium by erosion of the bank and deposition in the channel.
Figure 12d. Redredging channel and placing spoil on adjacent shore.

## COUNTY SHORELINE INVENTORY

The following series of maps are segments of the tri-county shoreline indicating bank type and areas of active shoreline erosion. A series of photographs is included to aid the user in understanding the nature of the shoreline. Table 1 gives approximate erosion rates for the various shoreline types.

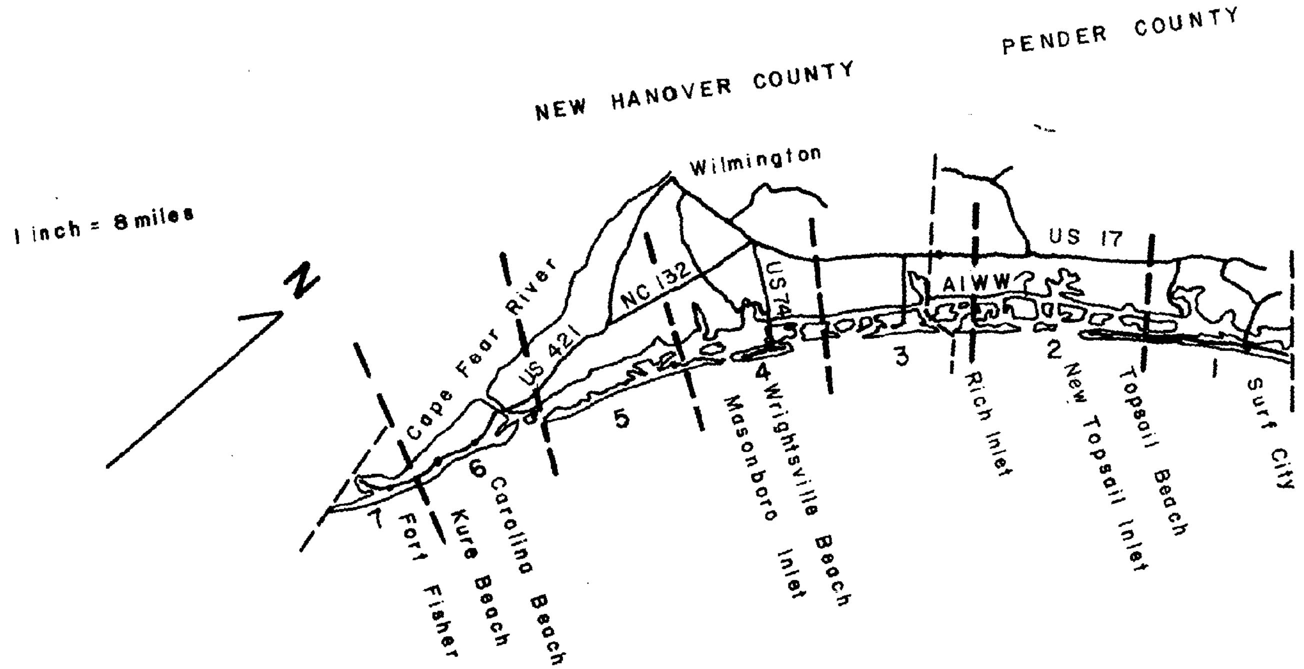



Figure 13a. **Location of Shoreline Segments**

BRUNSWICK COUNTY

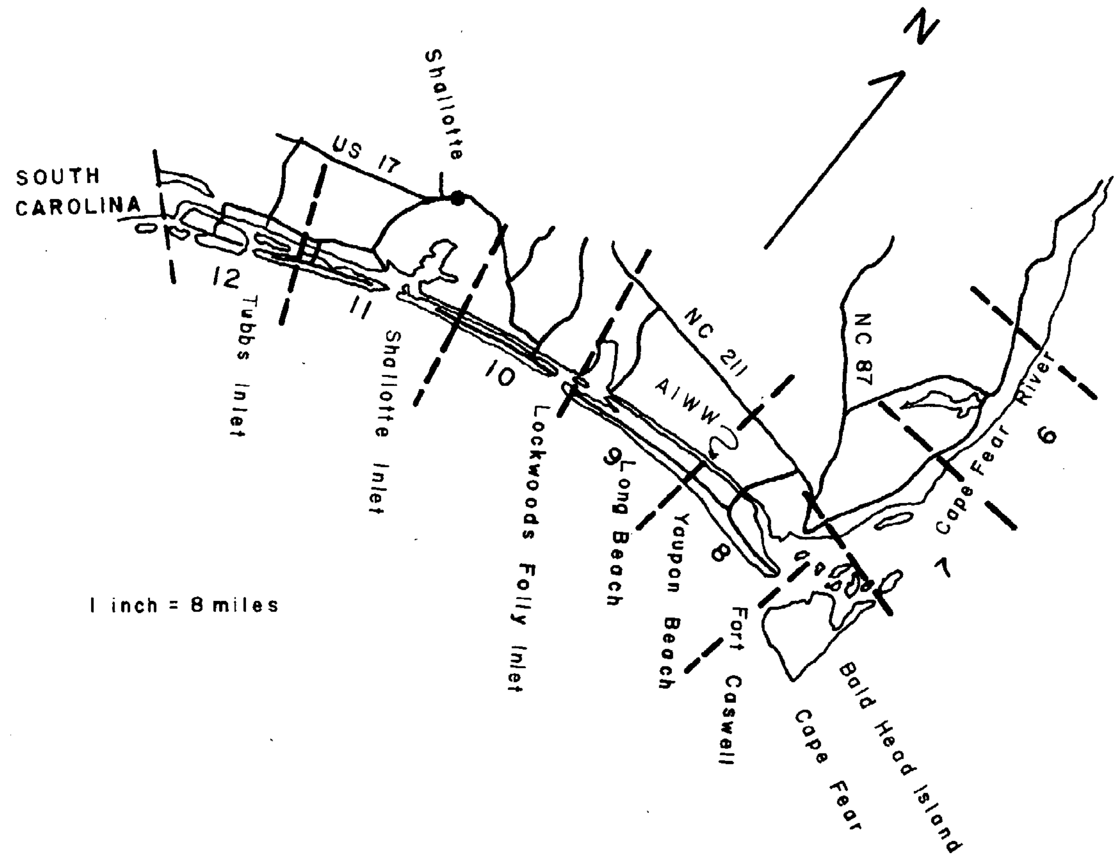
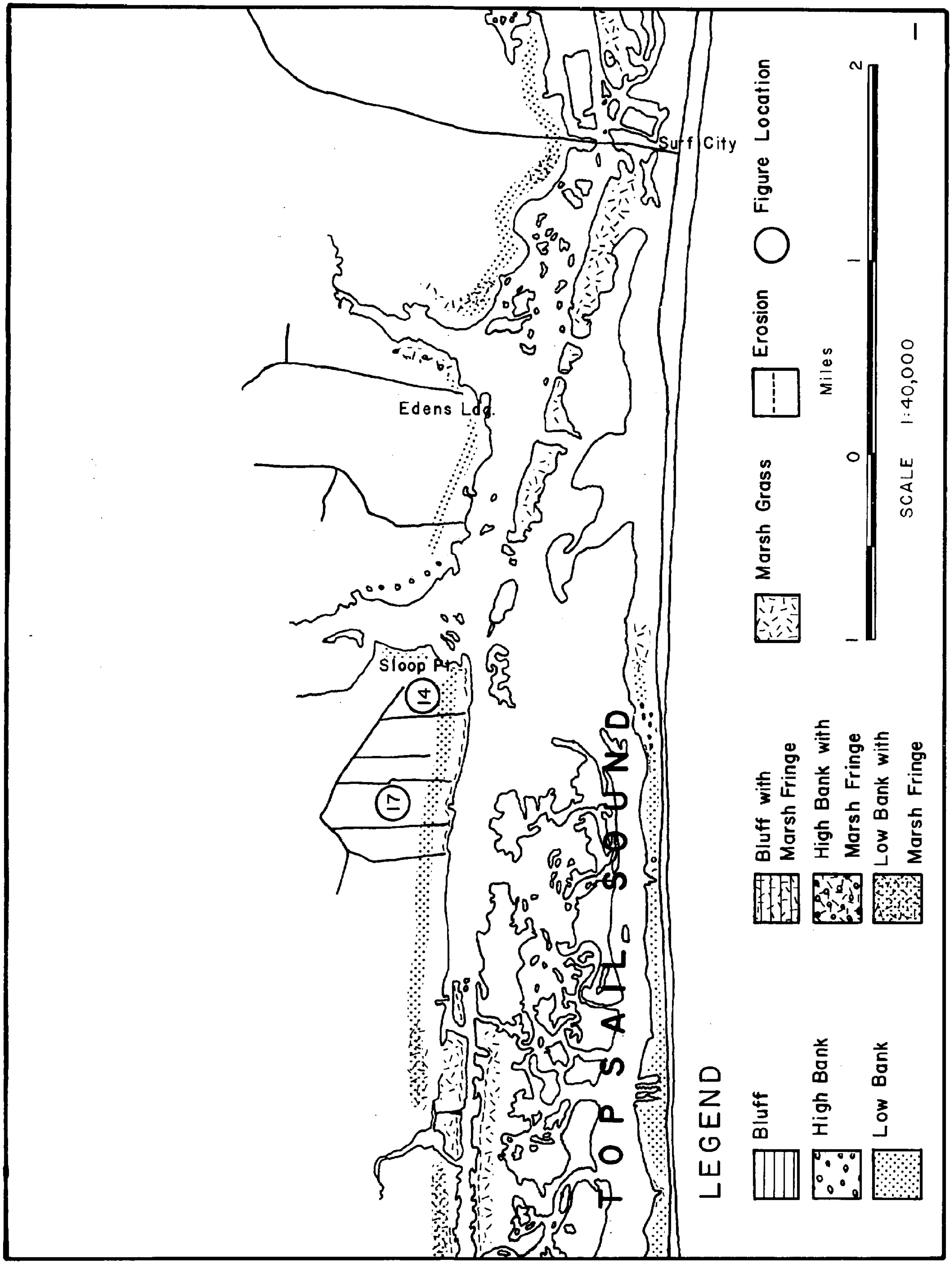
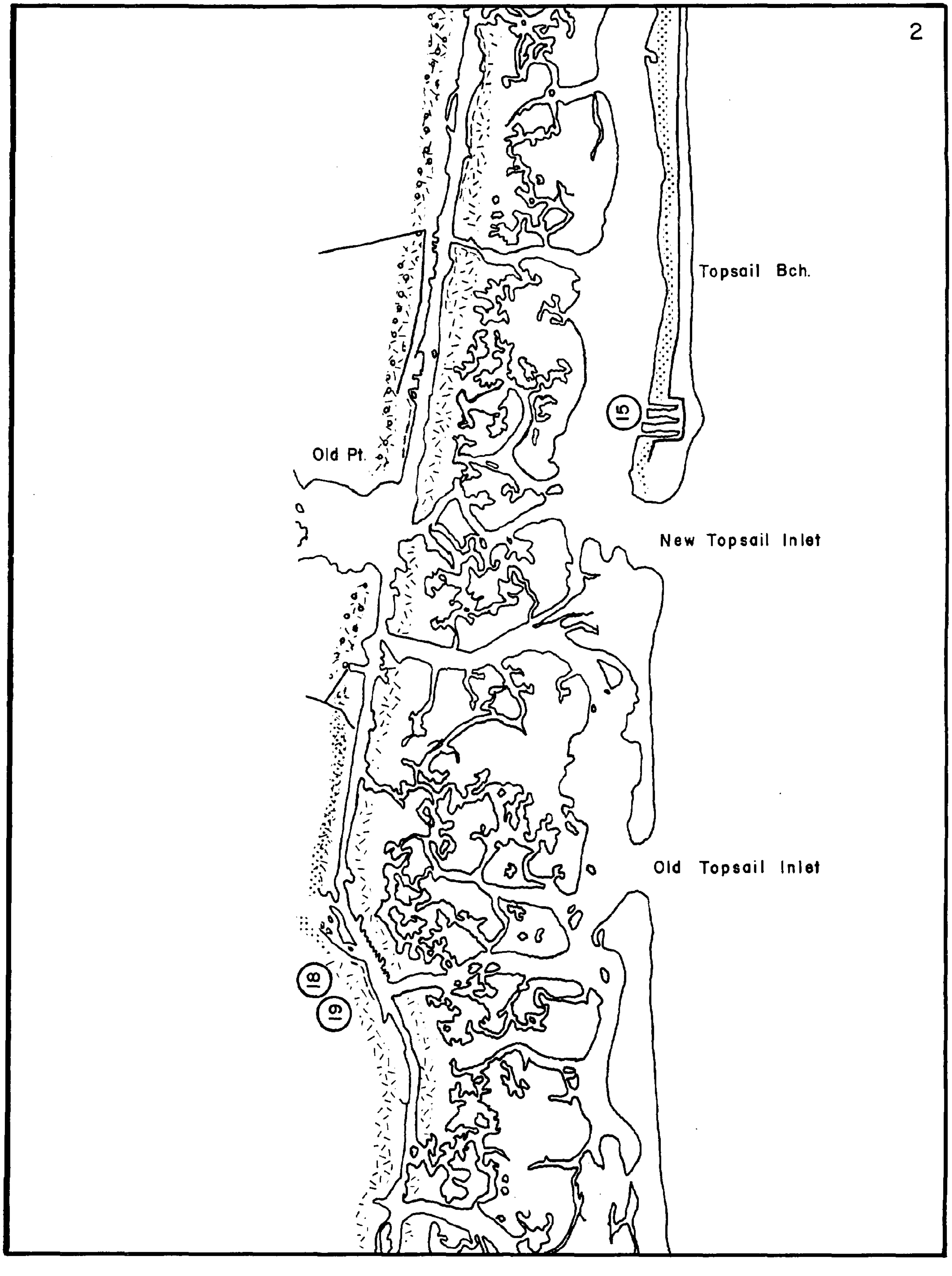



Figure 13b. **Location of Shoreline Segments**


Surf City
Edens Ldg.
Sloop Pt.
14
17
TOPSAIL SOUND
LEGEND
Bluff
High Bank
Low Bank
Bluff with Marsh Fringe
High Bank with Marsh Fringe
Low Bank with Marsh Fringe
Marsh Grass
Erosion
Figure Location
Miles
1
0
1
2
SCALE 1:40,000


2
Topsail Bch.
15
Old Pt.
New Topsail Inlet
Old Topsail Inlet
18
19

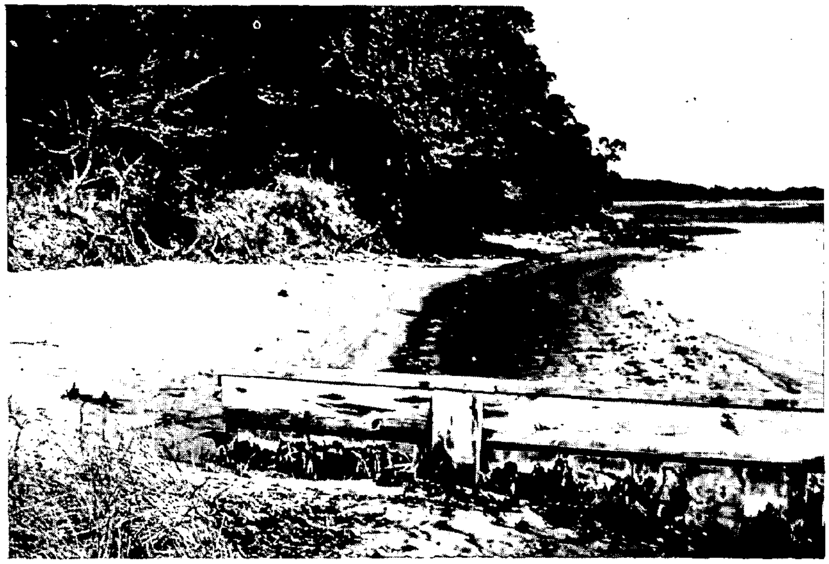


Figure 14. Eroding low bank without marsh fringe.

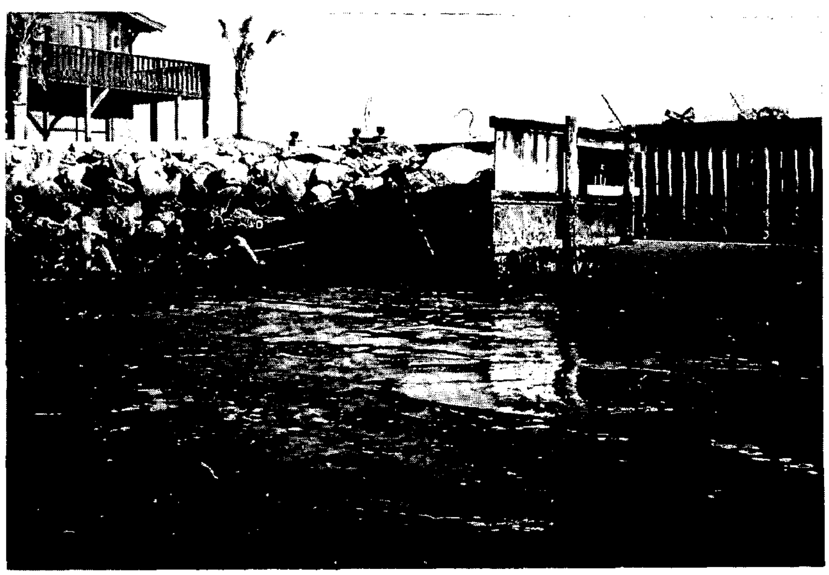


Figure 15. Failing bulkhead replaced by rip-rap.

Figure 16. Examples of poor attempts to protect shoreline property are numerous.

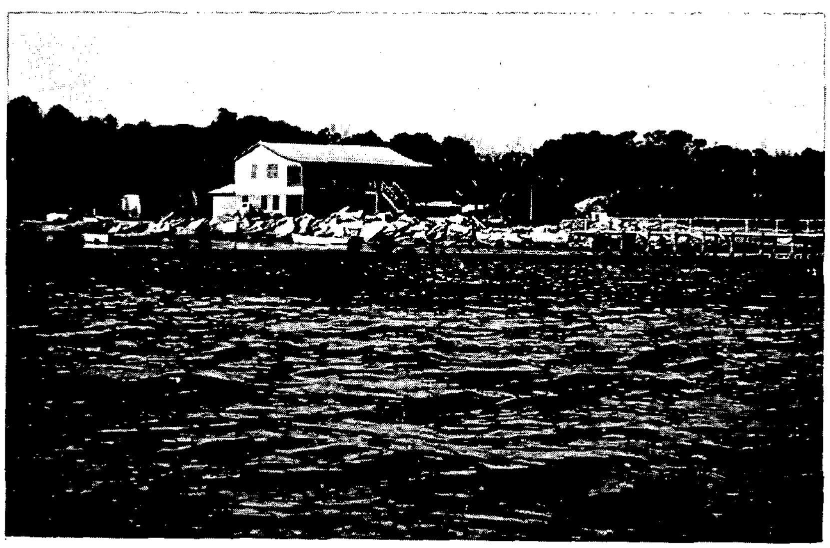
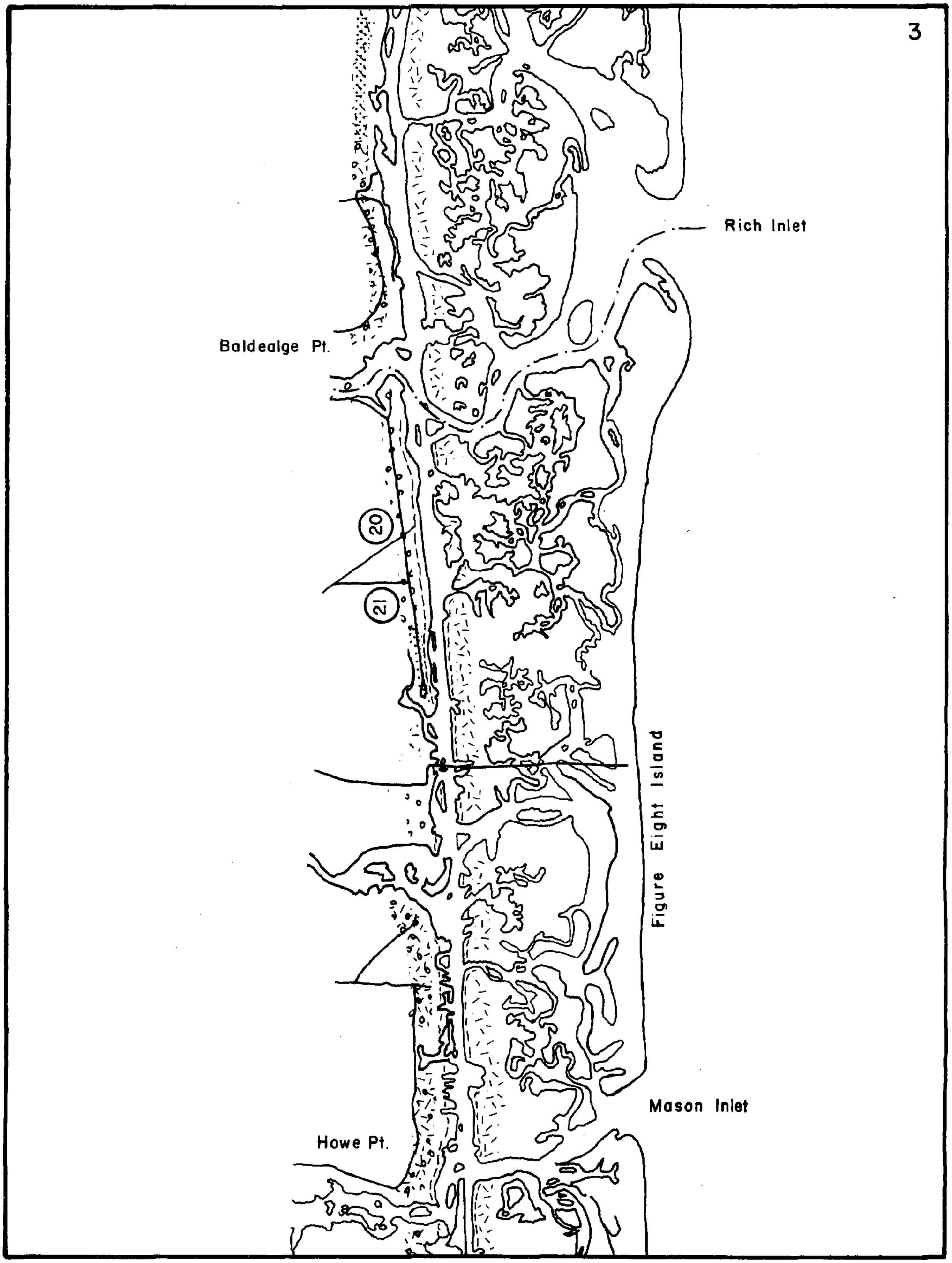


Figure 17. Although somewhat successful, the rip-rap protection system is far from being aesthetically pleasing.

Figure 18. Position of waning tree gives evidence of shoreline recession.

Figure 19. Recession of protective marsh grass.


3
Rich Inlet
Baldealge Pt.
20
21
Figure Eight Island
Mason Inlet
Howe Pt.

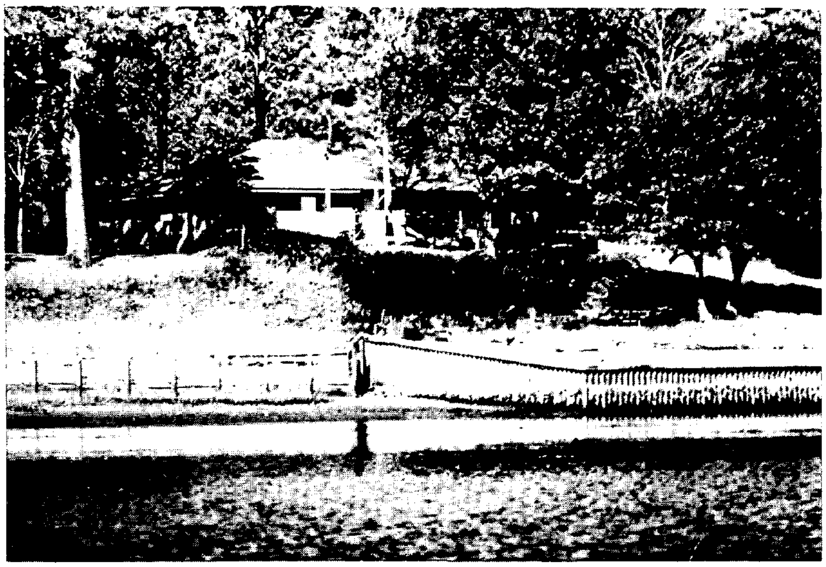


Figure 20. Properly maintained bulkheading proves to be effective for controlling erosion.

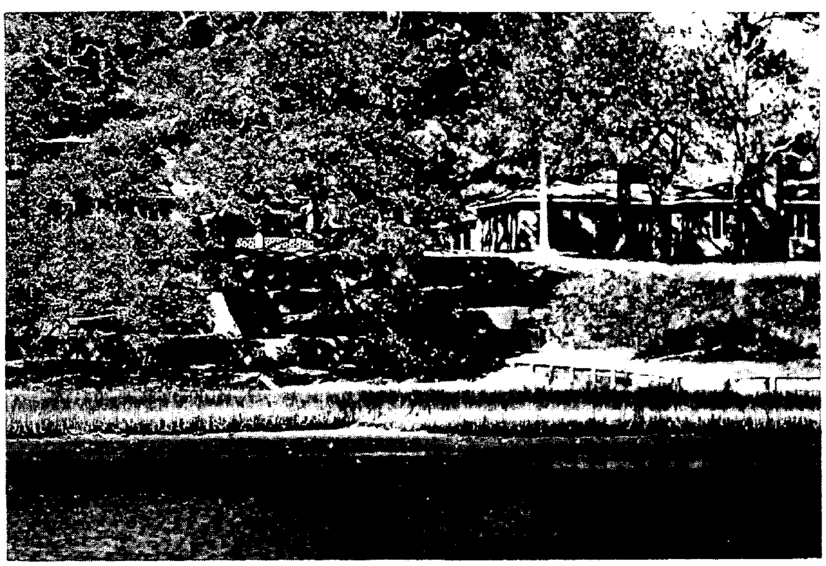
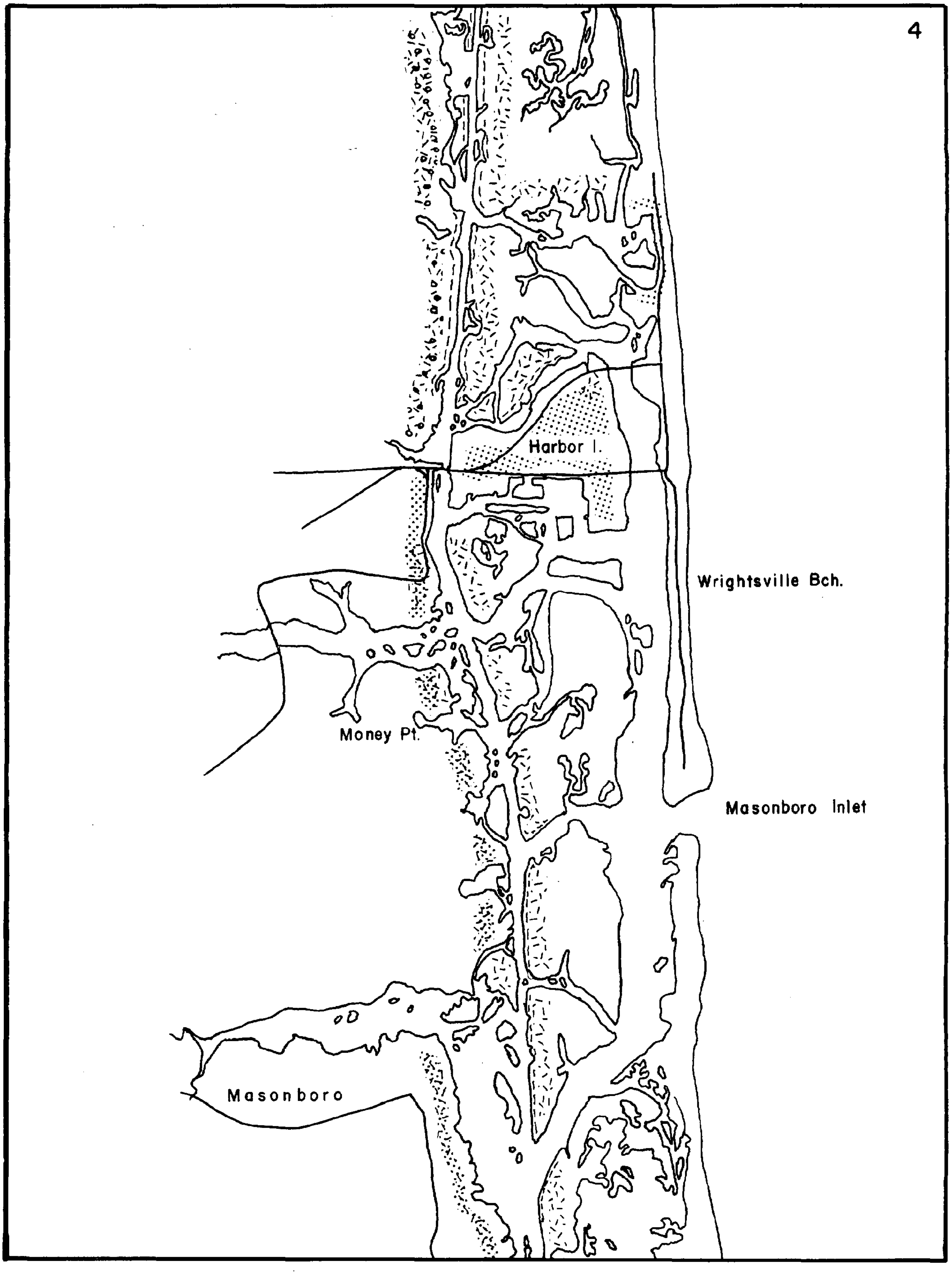


Figure 21. Such bulkheading as this will prove to be effective after eventual loss of protective marsh fringe.


4
Harbor I.
Wrightsville Bch.
Money Pt.
Masonboro Inlet
Masonboro

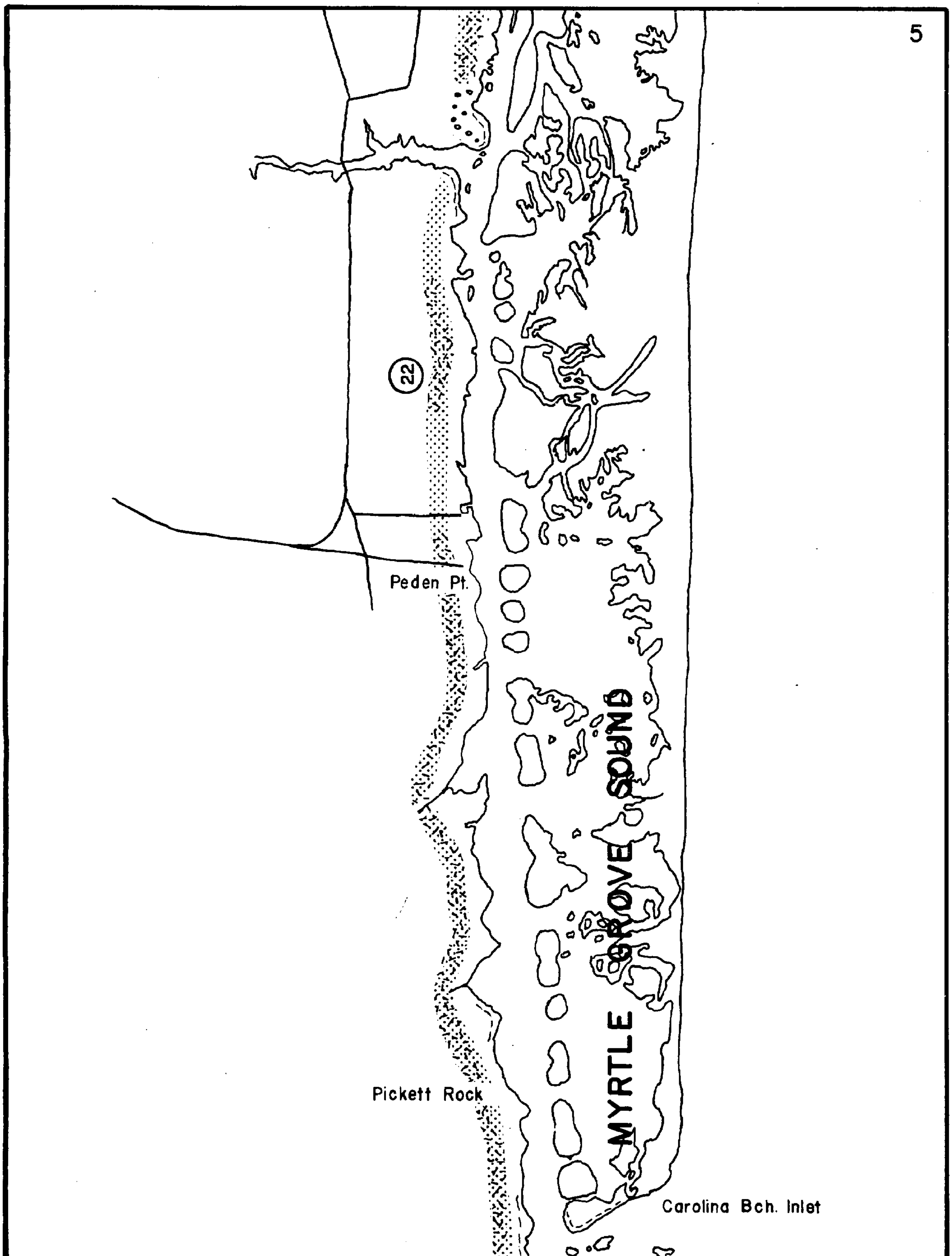

5
22
Peden Pt.
MYRTLE GROVE SOUND
Pickett Rock
Carolina Bch. Inlet

Figure 22. This modern shoreline is encroaching upon a relict forest.

Figure 23. The marsh fringe serves as a buffer zone between the water and the mainland.

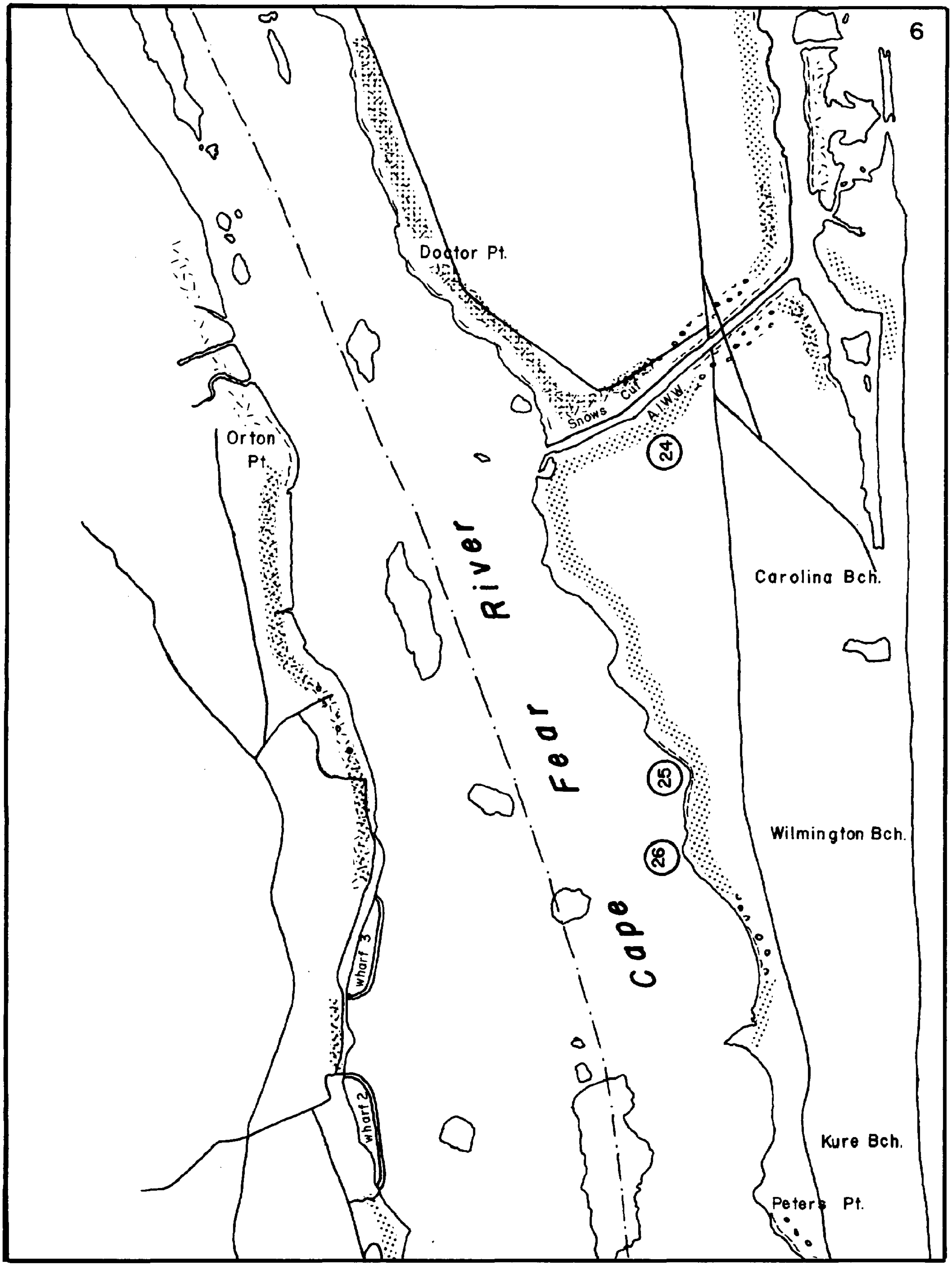

6
Doctor Pt.
Orton Pt.
Snows Cut
AIWW
24
Cape Fear River
Carolina Bch.
25
26
Wilmington Bch.
wharf 3
wharf 2
Kure Bch.
Peters Pt.

Figure 24. Narrow sections of the waterway with high bank shorelines are particularly vulnerable to erosion.

Figure 25. Escarpments along the Cape Fear River are created by high energy wave erosion during severe storms.

Figure 26. The exposed tree trunk is indication that the shoreline has receded.

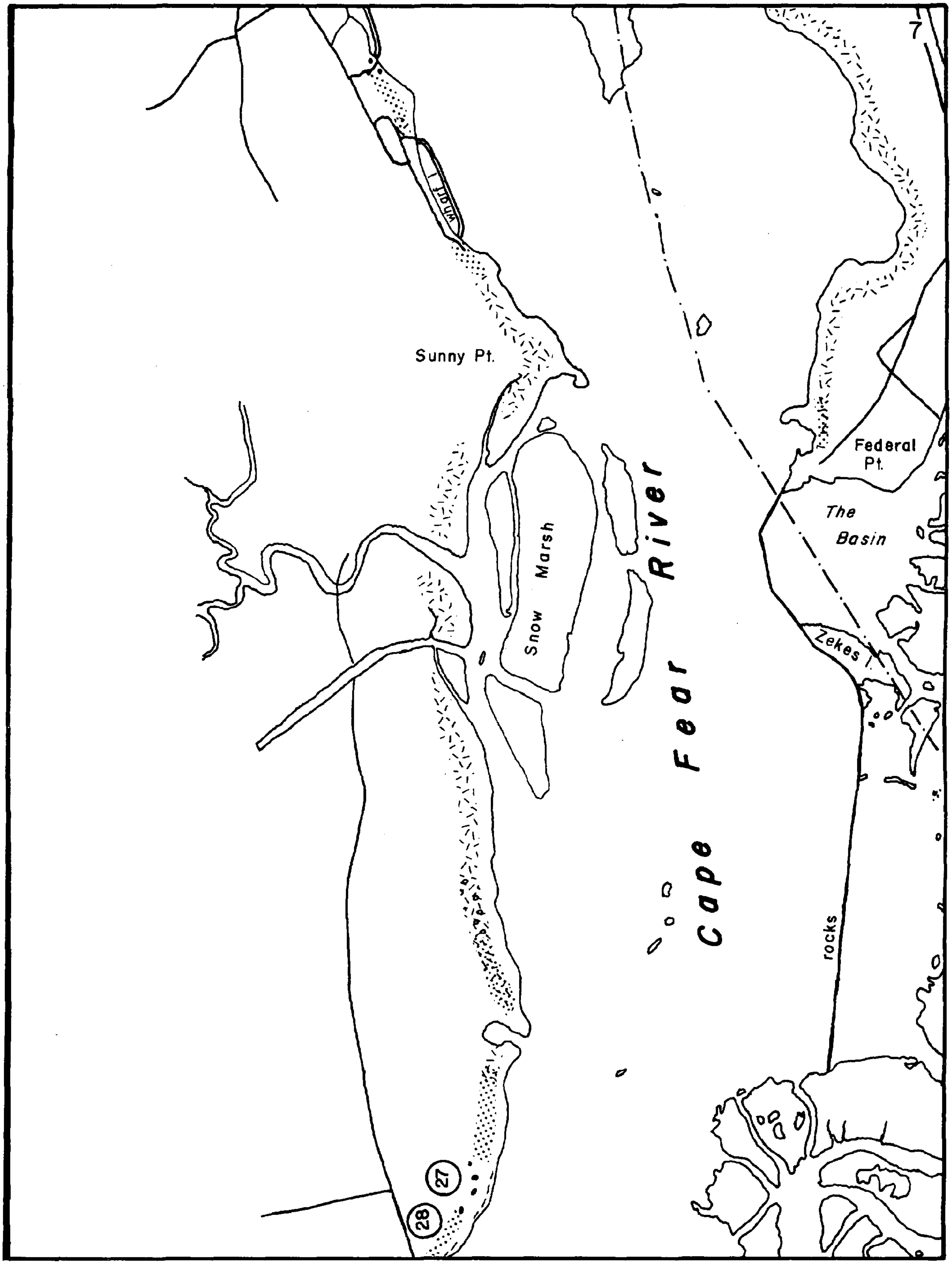

7
Sunny Pt.
Snow Marsh
Cape Fear River
Federal Pt.
The Basin
Zekes I
rocks
27
28

Figure 27. Low bank developments such as this may be damaged due to flooding caused by seasonal storms.

Figure 28. Rip-rap composed of materials such as concrete blocks, bricks, etc. are somewhat effective although aesthetically unattractive.

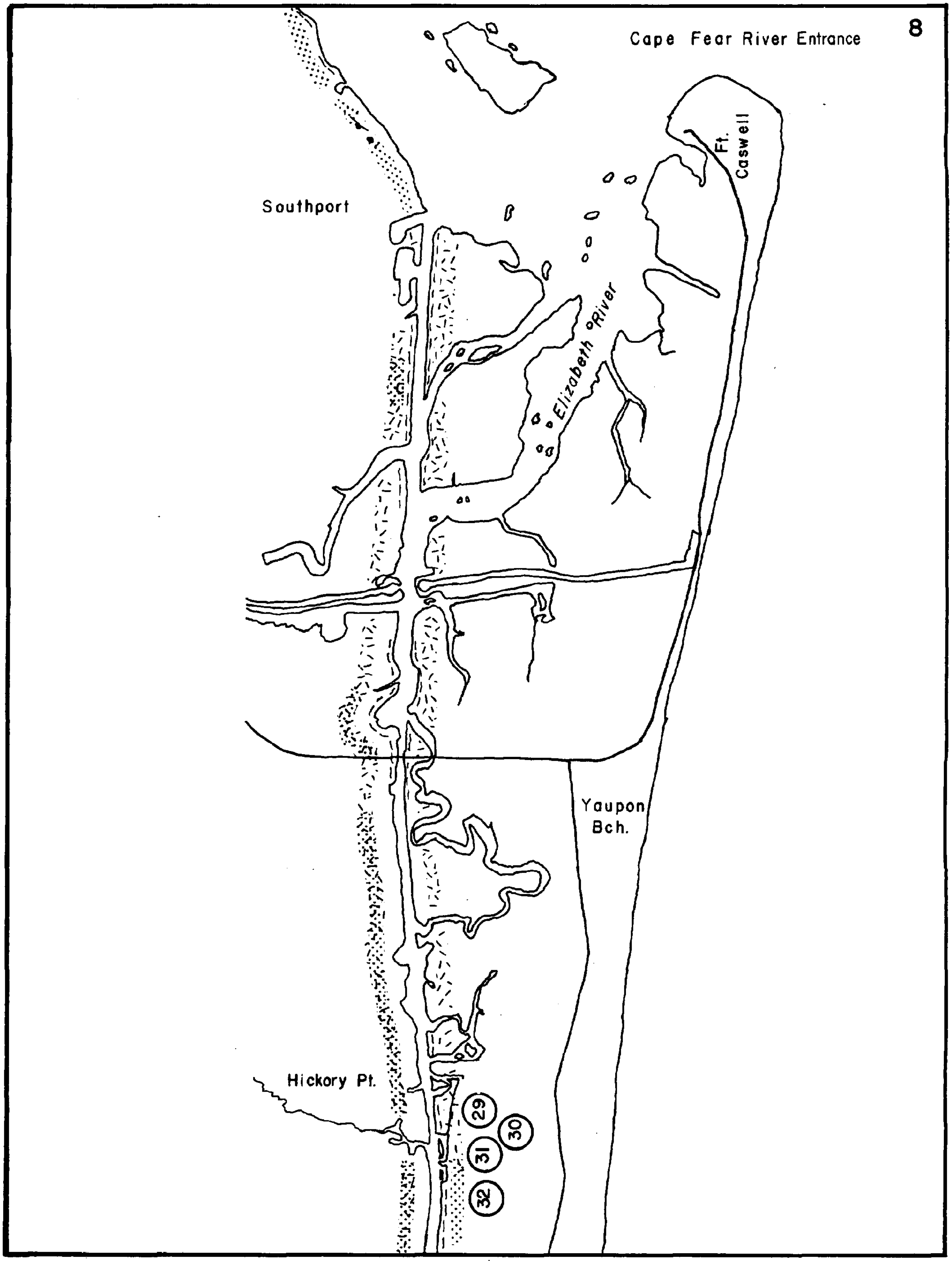

8
Cape Fear River Entrance
Southport
Ft. Caswell
Elizabeth River
Yaupon Bch.
Hickory Pt.
29
30
31
32

Figure 29. Bulkheads such as this one are expensive to build and require periodic maintainance.

Figure 30. Failure of this bulkhead resulted in the loss of valuable property over a ten-year period.

Figure 31. Erosion of this marsh results from boat wake action at low tide.

Figure 32. Undercutting has resulted in the felling of trees and shrubs along this low bank.

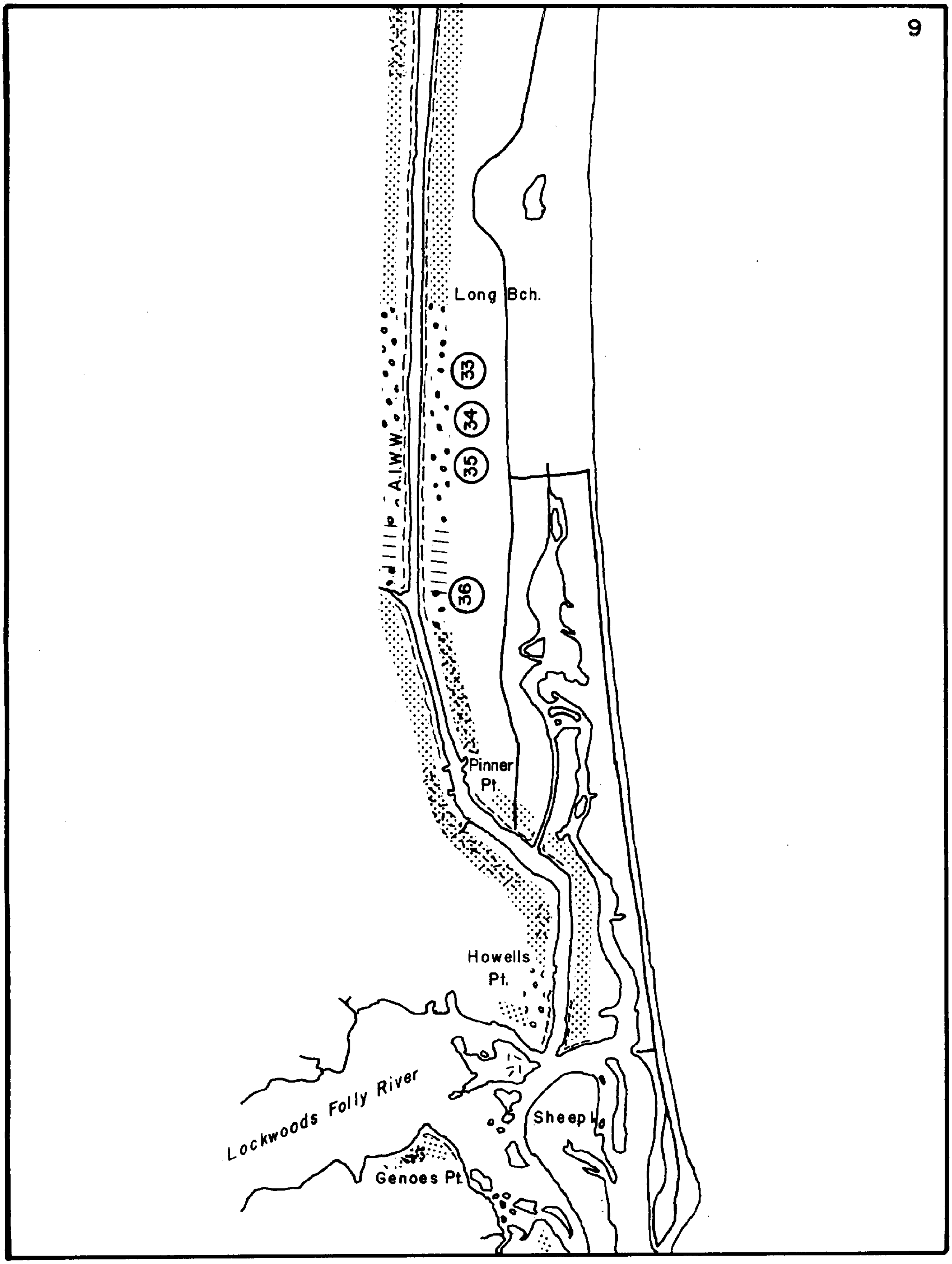

9
Long Bch.
33
34
35
36
AIWW
Pinner Pt.
Howells Pt.
Lockwoods Folly River
Sheep
Genoes Pt.

Figure 33. Stairways such as this one frequently fall victim to shoreline erosion. Note that due to the accelerated erosion rate, the bank recedes before destruction of the stairs.

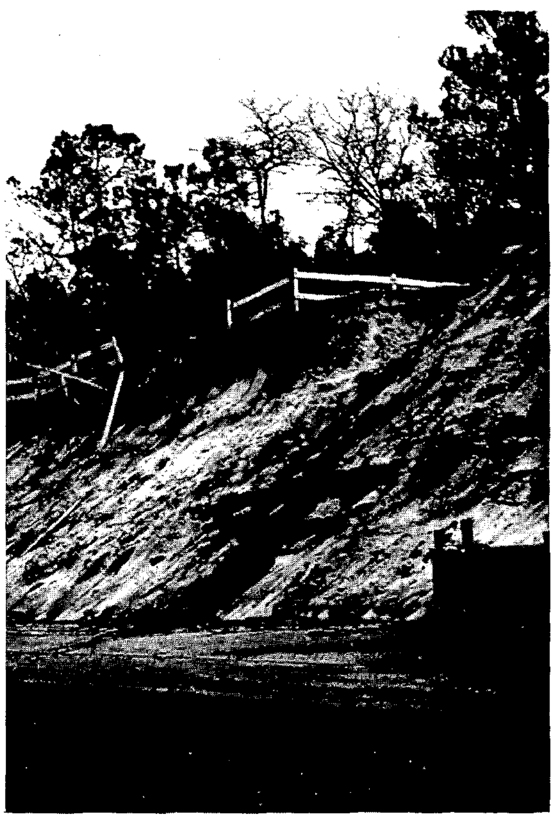


Figure 34. Note the fence posts exposed due to slumping of this bluff.

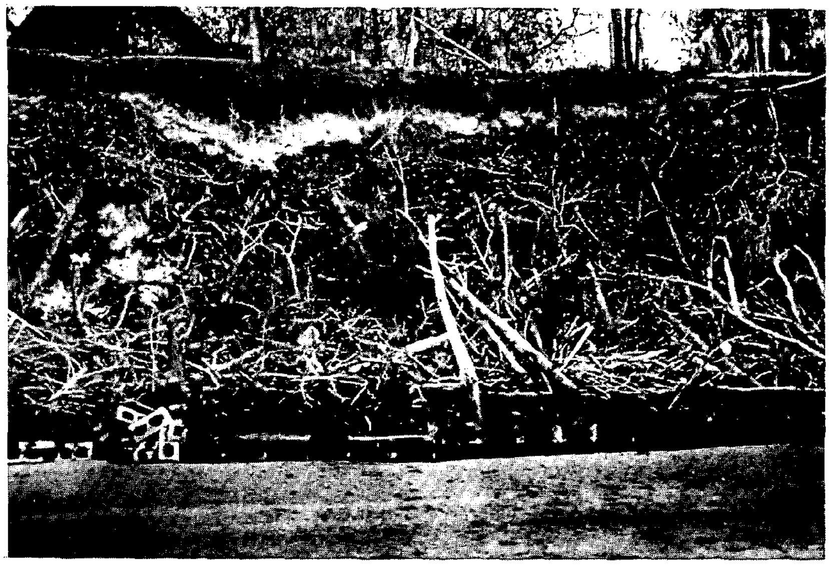
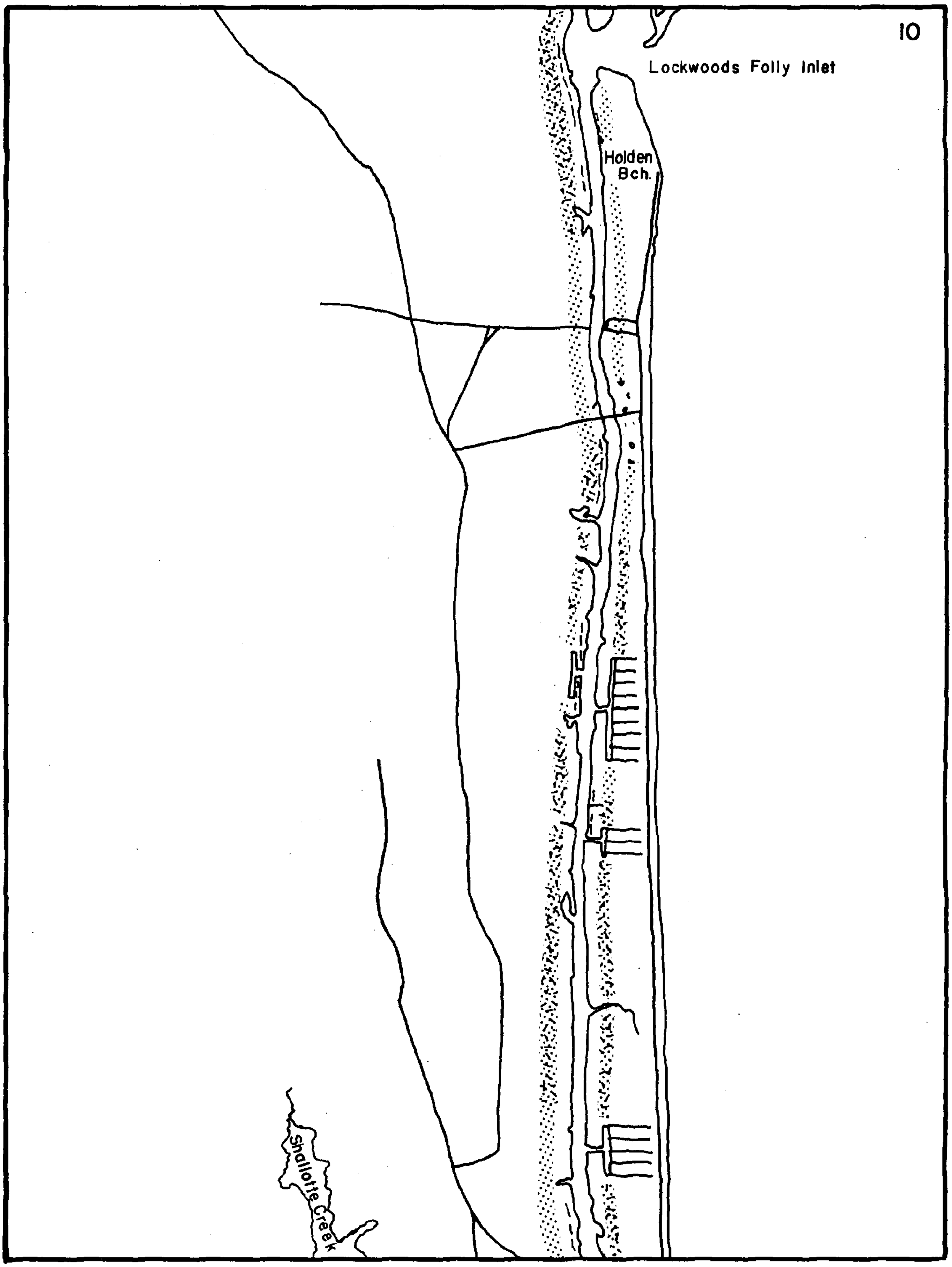
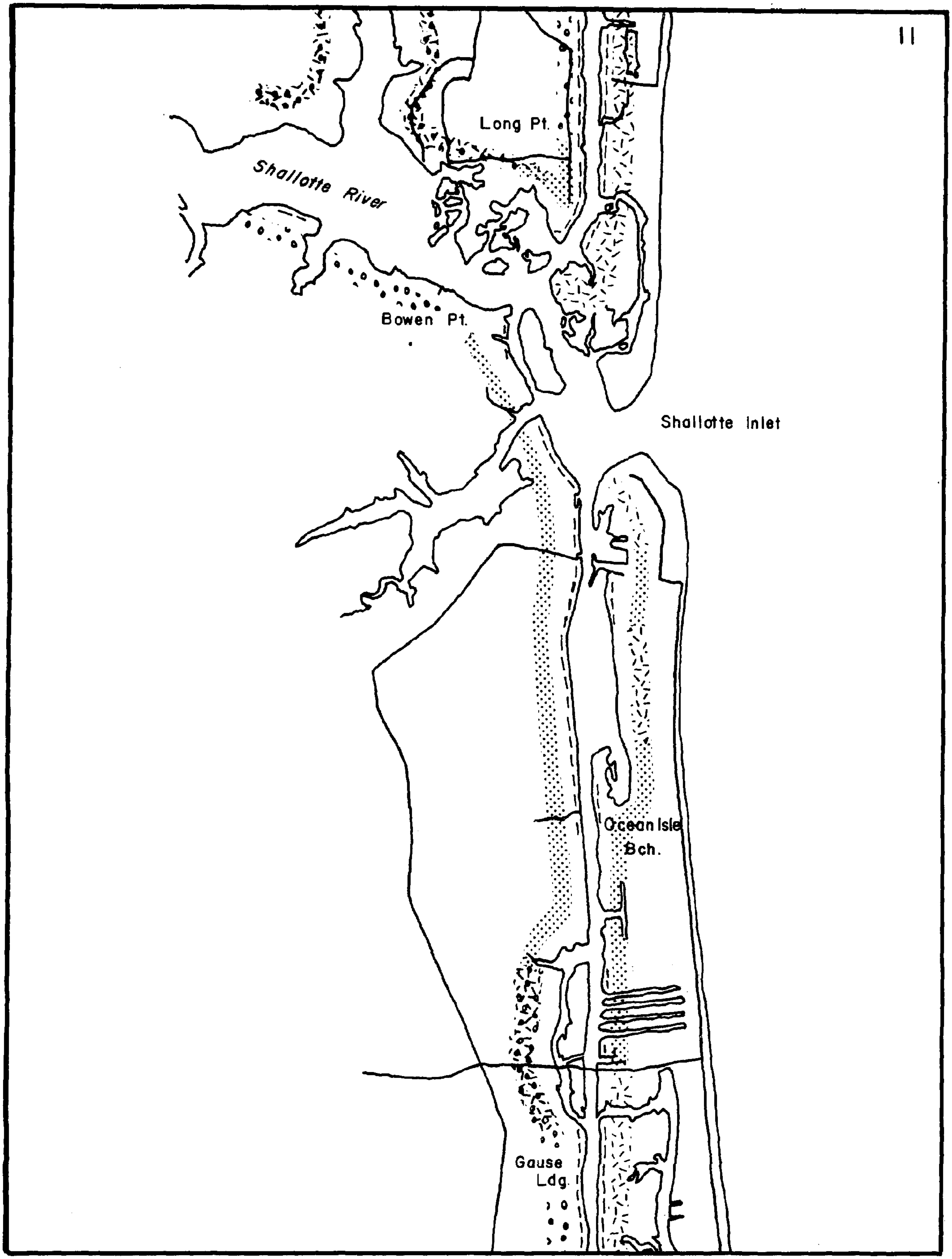


Figure 35. Shoreline protection measures such as this are not very effective at controlling erosion.

Figure 36. Stabilization of this high bank has been accomplished through the use of concrete-filled bags. In such critical erosion areas, the measure will prove to be only a temporary solution.


10
Lockwoods Folly Inlet
Holden
Bch.
Shallotte Creek



11
Long Pt.
Shallotte River
Bowen Pt.
Shallotte Inlet
Ocean Isle
Bch.
Gause
Ldg.

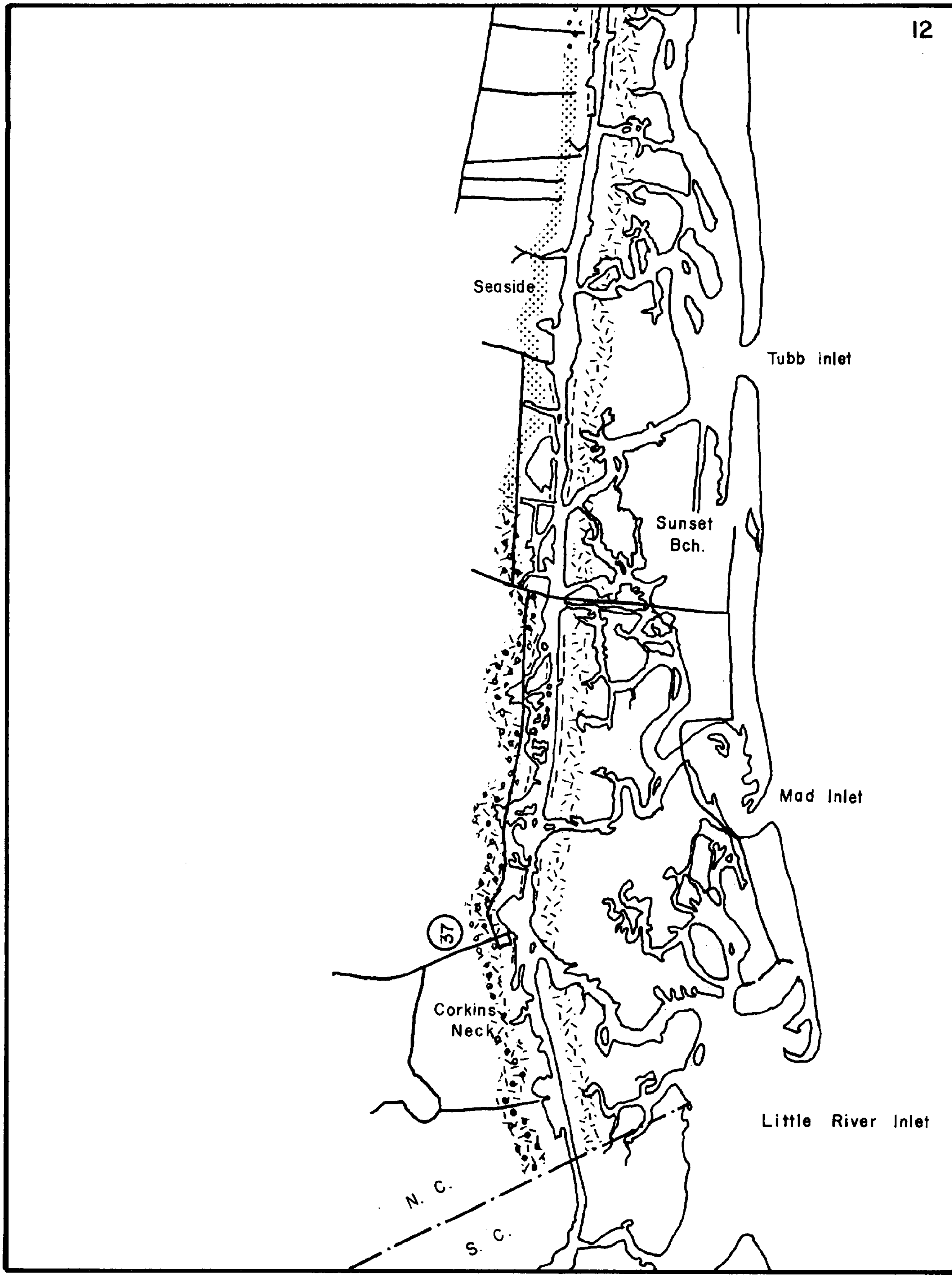

12
Seaside
Tubb Inlet
Sunset
Bch.
Mad Inlet
37
Corkins
Neck
Little River Inlet
N. C.
S. C.


Figure 37. The owner of this restaurant will soon have to utilize some type of shoreline protection measure in order to protect his property(note the power pole).

Figure 38. Failure of bulkhead due to wake activity on AIWW. This structure is so located that it receives the full impact of the boat wake.

## CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that rates of erosion may vary considerably even between adjacent segments of the shoreline. Although the erosion inventory presented in this report serves as a guide to estuarine shoreline erosion, it is not a replacement for on-site evaluation of any area. Man-made or natural changes of the shoreline may alter the erosion process along any section of the study area.

The following conclusions have resulted through careful analysis of the estuarine shoreline erosion problem for the tri-county area:

1. Most of the AIWW utilizes man-made passageways, and the erosion problem along the waterway is induced primarily by the activities of man. Any alteration of the shoreline that must be made in order to cope with erosion should be viewed as solutions to a man-made problem. Thus, any aesthetic arguments over environmental changes due to shoreline modification must consider that most of the AIWW is not part of the natural system and has to be approached as such.

2. Portions of eroding bank shoreline can and should be controlled through the use of shoreline protection techniques. Landowners would benefit because property loss would be controlled, and the filling-in of the waterway channel due to sediment derived from eroding shoreline would be reduced.

3. For certain areas, no economically feasible shoreline modification could reduce the erosion problem. Erosion of marshland and stretches of narrow waterway channels can be controlled through the establishment of "no-wake" zones, thus removing the mechanism(wakes) for erosion. This

would be particularly beneficial at high tide, when erosion potential of bank shoreline is generally the greatest.

4. Zoning ordinances that would establish land use codes along the estuarine shoreline could restrict landowners from building at areas of severe erosion or areas of high erosion potential. Low bank areas along the AIWW and the Cape Fear River are particularly vulnerable to flooding caused by seasonal storms, such as hurricanes. Large storms have raised water levels as high as ten feet above mean sea level in the tri-county area, causing property damage due to flooding and increased shoreline erosion. Low-lying areas should be considered as undesirable locations for future real estate developments. Building code regulations could create set-back lines for developments, thus removing permanent structures from immediate danger by shoreline erosion.

5. Finally, a "do-nothing" approach to the shoreline erosion situation should be considered. The purpose of the AIWW is to allow safe, efficient inland passage for commercial and private water traffic. Since construction of the AIWW predates most real estate developments along its shoreline, then erosion of the shoreline could be considered as a problem only for those people who purchased shoreline property without full consideration of the consequences of owning waterfront lots.

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